Investment, Uncertainty and Conventions

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Abstract

This paper tries is concerned with the key determinants of aggregate productive investment. We derive a theoretical macro accumulation function which relies on the accelerator principle. Specifically, the accelerator is complemented with two Kaleckian ideas: *utilization of capacity* and *profits* and two Keynesian ideas: *uncertainty* and *conventions*. In our proposal we consider two types of uncertainty: financial uncertainty which is proxied by real exchange rates and political uncertainty which is introduced by oil prices. Our contribution also captures the effect which arises from the stock exchange market in order to deep in the relationship between real and financial sector. Finally, we rescue the role of conventions to cope with uncertainty and include some of these variables as deviations from their normal or conventional values. In the second part of the paper we estimate the investment function by means of the *Generalized Method of Moments* (GMM) method and the *system GMM* method on a panel of 12 OECD economies over the period 1970-2010.

***Keywords**: Accumulation, Accelerator, Conventions, Uncertainty, Keynesian economics.*

***JEL Classification:** B22, C23, E22.*

1. Introduction

From a Keynesian standpoint, private productive investment is the key macroeconomic variable since it affects both the demand side and the supply side of the economy. Disagreements prevail, however, in the way the investment function is formulated. Even in The General Theory (Keynes, 1936) there are two conflicting theories of investment. In chapter 11 Keynes presents 'the marginal efficiency of capital' that gives preeminence to the interest rate in the way advanced by Irving Fisher (1930) and other neoclassical economists. Yet, in chapter 12 Keynes claims that the key determinant of investment is the state of long-term expectations, which are formed in an atmosphere of uncertainty. New terms, like 'animal spirits', 'state of confidence' and 'conventions', come to the stage for the first time, displacing the traditional interest rate variable. Econometrics does not resolve this dilemma because most of investment functions perform rather badly and because the direction of causality is not always clear. The only conclusion derived from econometric studies is that models of investment based on the principle of acceleration may not be that unsatisfactory (Baddeley, 2003). In this paper we estimate a post-Keynesian investment function based on the 'acceleration principle' but flexible enough to account for the influence of distributive and financial variables, accounting for uncertainty. The introduction of the conventional values as a way to deal with uncertainty has a significant role to play in the empirical literature, not always acknowledged.

Using panel data, we apply the linear generalized method of moments (GMM) and the system GMM in an attempt to find a dynamic model, which captures the common structure among different economies that supposedly globalization brings about. (Alexiou, 2010; Servén, 2003).

We proceed after this introduction of section 1 to the theoretical formulations of the problem in hand in section 2. We discussed in section 3 the data employed along with their sources, followed in section 4 by our justification and elaboration on the econometric methodology employed for the purposes of our paper. The results and their discussion are provided in section 5. Finally, we summarise and conclude in section 6.

2. The investment function

As mentioned above, there is an important controversy about the specification of the investment function. This controversy is evident not only among different schools of thought, but even within the same paradigm. The Post Keynesian controversies are a typical example. In view of this in what follows we begin with a brief discussion of the alternatives in our attempt to account for them in an ultimate specification that is subsequently tested against real data.

Our starting point is the basic Post Keynesian investment function, which shows how accumulation, $a=I/K$, where I is investment and K is capital stock, is linked to capacity utilization *(u)*, as in equation (1):

$$a = \frac{I}{K} = \alpha_0 + \alpha_1 u \tag{1}$$

where capacity utilization is defined as in (2):

$$u = \frac{Y}{K} \tag{2}$$

where Y is the output. This variable *(u)* could be further related to expectations about the future and the level of economic activity.

An alternative version of this traditional model that accounts for the 'normal' or 'conventional' capacity utilization, and considers the gap between current capacity and its 'normal' level as the main explanatory variable, is as in equation (3):

$$a = \frac{I}{K} = \beta_0 + \beta_1 (u - u^*) \tag{3}$$

Another relevant approach, which widens the initial function is the model introduced by Bhaduri and Marglin (1990). Bhaduri and Marglin (op. cit.) point to the current rate of profit as the main determinant of investment. This specification proposes that the rate of profit as a function of the rate of capacity utilization, u, and the profit share, π, which introduces the distribution process in an explicit way. The inclusion of the profit share in the model accounts for a new path of growth, the profit-led growth, where growth and capital accumulation move in the same way (Dutt, 2011). Moreover, profit share can be considered as an indicator of the amount of internal resources, which are available to finance future investment projects. Equation (4) summarizes this particular proposition:

$$a = \frac{I}{K} = \chi_0 + \chi_1 u + \chi_2 \pi \tag{4}$$

This new relationship has to be enhanced by including monetary elements like the interest rate, i. Although internal resources can be used to finance investments, in practice, the presence of shareholders supposes a limit to finance new projects by using this avenue and the bulk of investment is financed externally, i.e. by bank loans and corporate bonds. Although the interest rate is not the corner stone of the Post Keynesian investment function, it is relevant to include this variable because it plays a double role in capital accumulation. On the one hand, it is the case that movements of the interest rates are associated with an income redistribution process between rentiers and firms; in other words, what affects consumption decisions, and finally, expectations about future aggregate demand. On the other hand, increases in interest rates dampen investment as has been demonstrated by Kaleckian and Kaldorian/Robinsonian models of growth and distribution (Lavoie, 1995; Hein, 2007). We may, therefore, account for it by introducing the rate of interest as in equation (5):

$$a = \frac{I}{K} = \delta_0 + \delta_1 u + \delta_2 \pi - \delta_3 i \qquad (5)$$

However, in this function there is no room for other variables, which have been emphasized in the literature, as for example the impact of uncertainty (Ferderer, 1993b). The state of confidence (uncertainty, for short) should also be present in all Keynesian explanations of investment. Entrepreneurs form their expectations on demand and profits in an atmosphere of uncertainty. The presence of uncertainty, *U*, has been emphasised especially so in the case of economic growth via its impact on *I/K*. To the extent that *I* influences *I/K*, the economy moves faster, markets are bigger than in the past and links between individuals are stronger than ever. Uncertainty could emerge from different sources. A number of them can be mentioned: political regimes, natural disasters, the development of the markets, or the weight that individuals give to their arguments. In practice, uncertainty is approximated by different variables, for instance, demand, inflation, interest rate, unemployment, international trade, profit, technology, sales, stock market index, taxes, oil price and the possibility of a crisis are the most popular proxies[1]**.** The way variables are introduced varies significantly. Neo-Keynesian economists identify uncertainty with risk and measure both of them by the standard deviation of the chosen variables (let say, stock market volatility) (this literature is surveyed by Carruth et al, 2000; see, also, the pioneering work of Pindyck, 1991). Post-Keynesian economists emphasize that fundamental uncertainty cannot be measured by statistical methods. It will show up via liquidity preference as Davidson (1991, 2002) has continuously insisted upon. In Post-Keynesian framework the influence of uncertainty on accumulation becomes very important. Businessmen have to consider a

[1] Stockhammer and Grafl (2010) survey the post-Keynesian literature, led by Littleboy (1990), Ferderer (1993a, 1993b).

long-term horizon in order to decide how and where to invest. They also have to take into account the presence of sunk costs due to investment, which are often irreversible and imply the purchase of very specific capital goods. So, conventions become the skeleton of businessmen´s rational behavior, whereas the state of confidence helps individuals to define their expectations and decide.

Equation (6) collects all the different determinants of accumulation, which have been suggested by the previous approaches:

$$a = \frac{I}{K} = \varphi_0 + \varphi_1 u + \varphi_2 \pi - \varphi_3 i - \varphi_4 U \qquad (6)$$

Considering equation (6) the kernel of a Post-keynesian investment function, our proposal widens this in several senses. First, by introducing conventions, which are the way in which entrepreneurs take investment decisions in a world dominated by fundamental uncertainty. It is the value that has prevailed in the recent past and people expect to be maintained in the future (Dejuan, 2007). If, for any reason whatsoever, this value changes and is kept at the new level long enough, it may become the new convention. This is an example of hysteresis, so frequent in macroeconomics. Specifically, some of the variables have been defined as deviations from their 'normal' or 'conventional' value, this is actually what permits us to collect some elements which had been absorbed by the intercept in models (4)-(6). All the 'conventional' levels which have been inserted in our proposal are determined by applying the HP filter (Hodrick and Prescott, 1980)[2]. Note that Lavoie et al. (2004) is a unique study, which includes conventions in its investment function. Specifically, the study models the 'normal' rate of capacity utilization. However, our approach accounts for this 'normal'rate and extends the notion of conventions to those variables which capture the presence of uncertainty in the model, because conventions become really important if they are related to uncertainty. In fact, the role of conventions is remarkable when businessmen have to take investment decisions in a world with no perfect information and without using mathematical analysis. The way in which we determine conventional levels is perfectly compatible with a kind of expectations which change throughout time.

Second, the existence of several sources of uncertainty, as we mentioned above, compels our model to capture the impact of uncertainty, *U*, by including two different proxies, deviations between current exchange rates and its conventional level, *de*, for

[2] See Appendix 2, which describes briefly this method.

financial uncertainty and deviations of volatility of oil prices, *dv*, for geo-political uncertainty. Notice that the volatility of the exchange rate is used frequently as a proxy of financial uncertainty. However, we are not interested in the impact of this element and prefer relating this proxy of financial uncertainty with the notion of conventional level which is entrepreneurs´ tool to cope with uncertainty.

Finally, our approach takes into account the influence of stock exchange markets, *X*, in order to clarify the role that these markets play in the investment decision instead of using the volatility of this market as a proxy of financial uncertainty as other studies did (Episcopos, 1995; Baum, Caglayan and Talavera, 2008). There is a conflicting relationship between investment and stock exchange markets. On the one hand, we can expect a negative impact of the development of these markets on productive investment, in those situations where the stock exchange market attracts private investors who look for a higher profitability. On the other hand, this market is a source of external funding. Theoretically, a firm which is getting a positive valuation for the market could obtain resources easily and finance new investment projects with a lower cost.

In order to explore the role of conventions, stock exchange markets and uncertainty is necessary to provide a new investment function which modifies equation (6) by considering other explanatory elements of the pace of accumulation. Specifically, the independent variables, which have been included in our analysis, are the rate of growth of output ($g_{i,t}$), the deviation between the effective capacity utilization and its 'normal' level ($du_{i,t}$), the profit share ($\pi_{i,t}$), the real long-term interest rate ($i_{i,t}$), the deviation of the real exchange rate based on labour unit cost from its 'conventional' rate($de_{i,t}$), the deviation between the volatility of oil prices and its 'normal' level ($dv_{i,t}$), and the stock-exchange index ($X_{i,t}$) [3].

To begin with our function the accelerator hypothesis must be considered, due to expectations about future demand are key in the investment decision. According to the old principle of acceleration (introduced by Clark, 1917), the rate of accumulation (that will be one of the independent variables of our model[4]) will evolve in parallel to the expected rate of growth of demand, to which production adjusts. A pure acceleration theory of investment requires: perfect foresight of future increases in demand; absence

[3] In Appendix 1 we explain how the variables are defined.
[4] Investment in year *t* is a flow that increases the previous stock of capital. After dividing this flow by the stock of capital in *t-1* we obtain the rate of growth of capital, i.e. the accumulation rate (a_{it}).

of technical progress (or Harrod neutral technical change that keeps constant the capital/output ratio); symmetry of the impacts of a rise and a fall of demand; constancy of other elements that may influence investment. Since these requirements are never fulfilled we would better connect the accelerator with past increases in demand. Specifically, $g_{i,t-1}$, refers to the rate of growth of production in the previous period.

Due to the fact that the previous accelerator term is only a proxy for the expected demand it is necessary to introduce an index of capacity utilization to correct mistakes. So, the term $du_{i,t-1}$ accounts for the deviations of capacity utilization from its 'normal' level. This is an economic concept, not a technical one (Garegnani, 1992; Kurz, 1991). In post-Keynesian economics (as in Classical and Marxian economics as well) the ratio 'capital/labour' is treated as fixed, once the technology has been chosen and capacity has been installed. In the short run, entrepreneurs adjust production to unexpected increases in demand overutilizing the installed capacity. From a long-run perspective, this adjustment entails a disequilibrium that calls for new investments in order to adjust the 'capital/output' ratio to its optimal or normal level. We assume that the 'normal' rate of capacity utilization is determined endogenously, so we cannot insert this element in the intercept of the model.

As we have said, economists inspired by Kaleki consider that increases in profitability provide firms with both the incentive to invest and the internal funds (Bhaduri and Marglin, 1990). Here we consider the 'share of profits', $\pi_{i,t-1}$, that it is easier to compute and appears directly in 'real' terms. The positive influence of profits on investment is specially felt at the industrial level. Savings are supposed to flow from the industries with profitability lower than normal to industries with the highest profitability, ensuring the tendency towards a uniform rate of profit on the new capital invested. The macroeconomic impact will only emerge after a generalized rise in demand that increases prices over and above wages or after a cluster of technical innovations that raises labour productivity above real wages.

We have advanced the role of the interest rate in the investment decision. Specifically, our model accounts for the term $i_{i,t-1}$, which refers to real long-term interest rates. *Ceteris paribus,* we can expect that the investment decided by the acceleration principle will be delayed if the cost of raising external funds increase above the conventional level and is expected to turn back soon. However, since demand expectations and interest rates move usually in parallel, the empirical effect of the second is overshadowed. In boom periods investment is high despite upward movements of interest rates. In recessions investment is almost nil despite the real interest rate may be negative. The interest rate may be also taken as a proxy of the state of credit, although it is a very imperfect one. Banks may continue lending at low interest rates to their best customers and refuse lending to the riskiest ones, no matter how much interest they are ready to pay. This will be seen as a credit crunch at a constant interest rate.

As we mentioned above, the deviation between current real exchange rate and its conventional level, $de_{i,t-1}$, is included. Exchange rates play a key role in order to establish labour unit costs, and so on, good prices in domestic and international markets. In general terms, a sudden and strong devaluation of the euro will stimulate European exports. Investment in Europe will rise to attend them. A strong revaluation of the euro will have the opposite result. It is remarkable the fact that even in the case of developed countries there are capital goods which are imported from other economies. This phenomenon is stronger in developing countries where possibilities of producing technological goods are reduced. Moreover, it is suitable to compute this element, even in the case of analyzing a sample which computes many European economies with a high amount of trade flows among them, due to the fact that the *Euroland* is not a close economy, and therefore, those impacts which emanate from foreign exchange markets have to be considered.

To continue with our analysis of uncertainty we compute the deviation between the volatility[5] of current oil prices and its conventional level, $dv_{i,t-1}$. This variable collects the presence of geo-political tensions which start in producer countries, expand straightaway to the rest of the world and exert pressures in financial and good markets. On the one hand, a high and unexpected increase of oil prices will be understood like a negative sign by financial markets, as a result instability and losses arise in the stock exchange markets what make more difficult to obtain external resources in this way. On the other hand, a rise in the price of imported commodities provokes cost-push inflation, a reduction in profitability and so forth a decrease in the amount of the available internal finance to invest.

Finally, we add the term $X_{i,t-1}$ to the previous equation. This collects the development of the main real stock-exchange indexes. Extreme volatility it is a proxy

[5] This volatility is calculated by using the 3-year moving standard deviation.

for financial uncertainty that may put investment to a halt. Even when volatility is moderate, the creation of a speculative bubble in the stock exchange may affect negatively productive investment. Savings flee from financial market in search for speculative gains. This interpretation contradicts Tobin's "q" theory that should not be considered a theory of investment but an indicator of the cost of raising money in the market.

From the previous analysis, we have obtained our investment function, which can be described as follows:

$$a_{i,t} = \gamma_0 + \gamma_1 g_{i,t-1} + \gamma_2 du_{i,t-1} + \gamma_3 \pi_{i,t-1} - \gamma_4 i_{i,t-1} - \gamma_5 de_{i,t-1} - \gamma_6 dv_{i,t-1} - \gamma_7 X_{i,t-1} + \varepsilon_{it} \qquad (7)$$

where γ_i are the coefficients which we are going to estimate, ε is a random error term and γ_o the intercept The independent term accounts for the determinant of investment not accounted previously. We accepted that the *state of credit* is an important variable of a Keynesian model. In fact it is so important that when we introduce the evolution of long-term credits, leverage ratios and so on, they overshadow the significance of the previous independent variables. But, which are the independent variables in these cases? Post-Keynesian claim that credit is demand (investment) driven.

3. Econometric methodology

This study treats the data as a panel, which permits us to analyze simultaneously the development of the rate of accumulation of capital through time among different countries. The main objective of this kind of method is to collect the unobservable hetegoreneity which appears among the data. So, we control individual effects[6] and temporary effects[7] at the same time. Moreover, the analysis of panel data has other positive aspects.[8] For instance, modeling this kind of data allows us to use a wider sample of information. Thereby, the variability and the degrees of freedom of the model are higher than in the case of an analysis on the same data by considering time series. There is also a reduction of the collinearity of the model. In this way, an increase in the efficiency of the estimators is evident. The results of panel data estimations also reduce

[6] These effects are different for each individual case but do not change through time.
[7] These effects exert the same influence on each individual case in period *t*.
[8] See Baltagi (1995) on the panel data estimation technique. See, also, Gujaraty and Porter (2010) on the advantages of panel data estimation.

the bias of the estimators due to the fact that it is possible to use all the available observations at the same time without having to aggregate the information.

Due to the fact that the phenomenon which we are concerned with is a dynamic relationship we estimate our proposal by using two techniques: the *linear generalized method of moments* (GMM) and the *system* GMM, which is an advance on the previous method. According to Baltagi (2006) this kind of dynamic relationship is summarized by (7) and (8):

$$y_{it} = \delta y_{i,t-1} + x'_{it}\beta + u_{it} \qquad (7)$$

where δ is a scalar, x'_{it} is 1×K, β is K×1, *i = 1, …, N* and *t=1, …, T.* u_{it} is described as in the following equation:

$$u_{it} = \mu_i + v_{it} \qquad (8)$$

where $\mu_i \sim IID\left(0, \sigma_\mu^2\right)$ and $v_{it} \sim IID\left(0, \sigma_v^2\right)$ are independent of each other and among themselves.

Two relevant features of the economic relationship, which is modelled by (7) and (8) is the presence of autocorrelation and fixed effects. To cope with these problems the *linear generalized method of moments* (GMM)[9] which was introduced by Arellano and Bond (1991) solves the presence of correlation problems between the lagged endogenous variable and the time-invariant component of the disturbance by using internal instruments. Specifically, *GMM* takes differences of the initial equation and includes as instruments lagged values of the levels of the right-hand side variables. Equation (9) shows the structure of the first step of the method:

$$y_{it} - y_{i,t-1} = \delta\left(y_{i,t-1} - y_{i,t-2}\right) + \left(x_{it} - x_{i,t-1}\right)'\beta + \left(u_{it} - u_{i,t-1}\right) \qquad (9)$$

where $\left(u_{it} - u_{i,t-1}\right)$ is a MA(1) with a unit root.

Equations (10) and (11) display the moment conditions which are used by the difference GMM estimator:

$$E\left[y_{i,t-s}\left(u_{it} - u_{i,t-1}\right)\right] = 0 \qquad (10)$$

$$E\left[x_{i,t-s}\left(u_{it} - u_{i,t-1}\right)\right] = 0 \qquad (11)$$

for $s \geq 2$; $t = 1,...,T$

The main disadvantage of this technique is the fact that in those cases where the regressors present persistence (autocorrelation and individual effects) through time,

9 i.e. *difference GMM estimator*.

lagged values would not be suitable instruments for the regression in differences. In order to account for this problem and improve the efficiency of the GMM estimator Arellano and Bover (1995) and Blundell and Bond (1998) developed the *system GMM*, which computes the equation in differences and the equation in levels. The instruments for the regression in differences are those which were used in the difference GMM estimator. In the event of the equation in levels the considered instruments are the lagged differences of the variables. Formula (12) shows the equation in levels:

$$y_{it} = \alpha_i + \delta y_{i,t-1} + x'_{it}\beta + u_{it} \tag{12}$$

where α_i collects fixed effects. In this specification y_{it} is a function of α_i, and it is correlated with the compound error. Specifically, the GMM system method uses the model in levels and looks for instruments which are correlated with y_{it-1} but not with α_i instead of eliminating α_i with the model in differences as the former method. In this case the moment conditions are given by formulas (13) and (14)

$$E\left[\Delta y_{i,t-s}\left(u_{it} + \mu_i\right)\right] = 0 \tag{13}$$

$$E\left[\Delta x_{i,t-s}\left(u_{it} + \mu_i\right)\right] = 0 \tag{14}$$

for $s \geq 2$; $t = 1,...,T$

The validity of both regressions can be check by using: a) the Sargan test of orthogonality between the instruments and the residuals, which permits to test the validity of the instruments; and b) the Arellano and Bond test for first- and second-order serial correlation[10].

4. Data

As we mentioned above, our proposal is tested against a panel which spans from 1970 to 2010 and includes annual information about the following economies: Australia, Belgium, Canada, Denmark, France, Germany, Italy, Norway, Austria, Spain, the United Kingdom and the United States. They differ from size, openness to international trade and financial institutions. In what follows in this section, we attempt to justify the period chosen for the empirical investigation part of this contribution and the countries chosen. This sample computes the main European economies and other countries like

[10]The models are estimated in differences so we have to expect the presence of first-order autocorrelation.

the United States and Canada which are relevant due to the size of their economies. This panel also includes Australia because the empirical literature about this country is scarce. The main source of information is the *AMECO* databank, where there is available annual information since 1960 for some of the analyzed countries. However, we have to reduce the considered period in order to balance the panel and use the most complete and homogenous information as possible. Specifically, the following time series have been provided by this source: capital stock, GDP, gross operating surplus, real long term interest rates and real exchange rates based on labour unit cost. Moreover, these data have to be enhanced by resorting to additional information. On the one hand, capacity utilization series are provided by the OECD database *Business tendency and consumer opinion surveys*. However, there is some missing information about these rates in the case of Australia and the United States[11]. On the other hand, annual oil prices are published by the *U. S. Energy Information Administration (EIA)* since 1861.

The main difficulties to obtain the required data appear in the case of the stock exchange indeces. The majority of this information is daily and in the best case covers the last 20 to 25 years. Another problem is the fact that there are often changes in the composition of the indeces throughout time. So this feature implies an important restriction in our model. To cope with it we consider five indexes, only those for which it is possible to find long-time series and are also representative of our sample. Specifically, we include the DAX index as the most representative one for of the ‘Old World’ stock exchange market and use it for all the European countries except for Spain and the United Kingdom, which incorporate their own index (IGBM in the former and FTSE 100 in the latter). In the Australian case we compute the AXS index, and finally, we consider the Standard & Poor's index for the United States and Canada. DAX index is calculated by the *Deutsche Bundesbank* which publishes these historical data since 1960. Standard & Poor's index is provided by *Standard & Poor's web site*, which offers information since 1957. AXS and FTSE index are published by *Wren Investment*

[11] Australian capacity utilization information comes from the Australian Chamber of Commerce and Industry (*ACCI Westpac Survey of Industrial Trends*), which publishes quarterly data since 1961. The United States capacity utilization information comes from the Federal Reserve website which provides monthly data since 1967 (*G.17 Industrial Production and Capacity Utilization, Capacity utilization: Total Industry*).

Advisers since 1875 in the first one and 1970 in the second one[12]. IGBM index is provided by the *IESE Business School University of Navarra* from 1940 to 2003. Since 2003 this information comes from *Bolsa de Madrid* web site.

5. Empirical Results

Table I reports the estimation of our investment function by applying the two different techniques briefly explained above: a) the *linear generalized method of moments* GMM; and b) the *system* GMM. The variables are one and two years lagged, since entrepreneurs are bound to figure out their evolution from recent movements. We compute two lags because previous experience shows the presence of delays in the investment processes which are superior to 12 months (Evans, 1969; Baddeley, 2003).

The first column (Model I) shows the parameters of the unrestricted version of our proposed relationship, which includes all the variables two periods lagged and was estimated by the *difference* GMM. The second one (Model II) provides the coefficients of the restricted model, which collects the final specification of our investment function and uses the Arellano and Bond (1991) technique. The following columns (Model III-V) report the results of those equations, which were estimated by *system* GMM. Specifically, Model III reflects the extended version of the equation, Model IV displays only the coefficients which are significant and includes an intercept, and finally, Model V drops the constant which has no impact in the model.

TABLE I. ESTIMATED COEFFICIENTS FOR MACRO ACCUMULATION FUNCTION (1970-2010)

Equation	MODEL I	MODEL II	MODEL III	MODEL IV	MODEL V
Dependent	a	a	a	a	a
Constant	0.0001**	0.0001**	-0.0067	-0.0090	
a (1)	0.6258*	0.6437*	0.4100*	0.4420*	0.4281*
g (1)	0.2527*	0.2249*	0.2375*	0.1954*	0.1950*
g (2)	-0.0198		-0.0268		
du (1)	-0.0034		-0.0027		
du (2)	0.0136	0.0150***	0.0477*	0.0436*	0.0493*
π (1)	-0.1063		-0.0834***		
π (2)	0.1180***	0.0430*	0.1664*	0.0945*	0.0724*
i (1)	-0.0401**	-0.0554*	-0.0599**	-0.0912*	-0.0956*

[12]Previous data about FTSE 100 are provided by London Stock Exchange.

i (2)	-0.0159		-0.0339		
de (1)	-0.0128*	-0.0137*	-0.0358*	-0.0262*	-0.0263*
de (2)	0.0069		0.0125		
dv (1)	-0.0002		-0.0001		
dv (2)	-0.0007*	-0.0009*	-0.0009***	-0.0008***	-0.0008***
X (1)	-0.0038	-0.0019***	-0.0057*	-0.0020*	-0.0020*
X (2)	0.0023		0.0041*		
Method	GMM	GMM	GMM-sys	GMM-sys	GMM-sys
Number of observations (countries)	455 (12)	456 (12)	467 (12)	468 (12)	468 (12)
Wald test of joint significance (p-value)	89062.86 (0.0000)	1312.35 (0.0000)	1228.62 (0.0000)	1138.19 (0.0000)	6649.49 (0.0000)
Sargan test (p-value)	357.38 (1.0000)	358.86 (1.0000)	26.62 (0.2720)	38.59 (0.1350)	38.19 (0.1450)
1st-order autocorrelation (p-value)	-1.44 (0.1491)	-1.36 (0.1739)	-8.37 (0.0000)	-10.22 (0.0000)	-10.26 (0.0000)
2st-order autocorrelation (p-value)	1.16 (0.2463)	1.11 (0.2678)	1.73 (0.0830)	1.63 (0.1030)	1.59 (0.1120)

Note: *, ** and *** indicate the statistical significance and the rejection of the null at the 1, 5 and 10 percent levels, respectively. Numbers in parenthesis show the lags of the variable.

Model I shows how the rate of growth of GDP in the previous period and the profit share in *t-2* have a positive impact on accumulation (0.2527 and 0.1180 respectively). As we expected from the theory there is a negative relationship between accumulation and interest rates (-0.0401). This specification also remarks how uncertainty depresses investment. Specifically, the effect of financial uncertainty is approximated by deviations of exchange rates (-0.0128) in *t-1*, and the small incidence of political instability by deviations of the volatility of oil prices by lagged two periods (-0.0007). The estimation of this specification by using GMM-sys is captured by Model III, which widens Model I by adding several variables, for instance, a positive influence of deviations of capacity utilization in *t-2* (0.0477) and a negative influence of the profit share in the previous year (-0.0834). Those variables which are significant in both models show a higher impact in Model III except the accelerator term. In Model III the impact of the stock exchange market is also significant. Notice that both lags play a role in the function, although they have conflicting signs (-0.0057 in *t-1* and 0.0041 in *t-2*). The first lag collects how an increase of the stock exchange index depresses investment due to the fact that this financial market attracts resources from the real economy. However, the second lag could be consider an example of the *q model*, which shows how a company, which is valued positively by the market, can use its position to obtain more affordable external funding.

Model II and Model IV exhibit the same determinants of the pace of accumulation, but the employed technique is different. The estimation of the function by using difference GMM (Model II) displays a positive influence of expectation about demand (0.2249), profit share (0.0430) and deviation of capacity utilization (0.0150) on accumulation. This model remarks a negative relationship between interest rates (-0.5540), the stock exchange market (-0.0019), deviations of exchange rates (-0.0137) and deviations of volatility of oil prices (-0.0009). These determinants are lagged by one period expect profit shares and deviation of oil prices. Finally, Model V presents the same structure as Model IV, although the former one eliminates the intercept of the model which is not significant. The impact and the sign of the variables in both models are quite similar except for the profit share which is lower.

In general terms, the empirics confirm our theoretical frame. As we expected, expectations about future demand are the corner stone of our function, what support the relevance of the accelerator principle in order to explain the path of accumulation. Regardless the econometric technique and the exogenous variables of the model the estimated coefficient for the rate of growth of GDP lagged one period is positive and higher than the rest of the parameters.

Profit shares and deviations of capacity utilization also have a positive incidence in the investment decision. The impact of the former one is twice the influence of the latter. Due to the fact that firms always maintain idle capacity, and therefore, the normal rate of capacity utilization is below the unit, changes in the rate of capacity utilization permit them to face to unexpected increases in demand without undertaking new projects. An increase of the rate of capacity utilization over its normal rate would stimulate investment only when this deviation is maintained in the medium- or long-run. However, the impact of the profit share is higher than the previous one because a rise in the profit share has a double effect, on the one hand, this is an indicator of higher profitability in the short- and the medium-run, which attracts new investments; and on the other hand, an increase in the profit share enhances the possibility of finance investment with internal resources.

These results point to the interest rate as the element, which can depress investment in a stronger way. This fact reinforces the Keynesian idea of establishing interest rates as the lowest and most stable as possible. Thereby, individuals can take their financial decisions in a frame where they have accurate expectations about the evolution of the cost of obtaining external resources.

Increases in the deviations of the exchange rate dampen accumulation in a considerable way, as pointed by our framework. Instability in exchange rates reduces trade flows and depresses expectations about external demand. However, the financial cost of a new project is more relevant than the movements of this variable. In those cases in which firms import capital goods is more probably that they decide to postpone an investment project in the event that the cost of obtaining financial resources is increasing than in the case that the currency is suffering depreciations. Moreover, this is reinforces by the fact that the weight of the internal trade is much bigger than the external one. So, those variables related with the domestic market will have a higher effect in accumulation.

The negative impact of the stock exchange is lower than the previous two indicators, this is coherently with the fact that firms finance their investment by using mainly banking facilities instead of attracting new shareholders (what rejects Tobin´s *q*). However, the negative impact of this variable reinforces the idea which we advanced above, the presence of a speculative bubble in the stock exchange crowds out investment in fixed assets. This impact is not very big due to the fact that if the price of financial assets rises, there would have been some investors which suffer an increase of their income and increase their consumption, what reduces the impact of this negative relationship.

Finally, the volatility of oil prices is the element which exerts the lowest negative influence in investment. This result is compatible with our model due to the fact that this proxy of uncertainty plays its role mainly in those situations where is a crisis and oil prices rise quickly.

6. Conclusions

The goal of this paper is to explain, from an aggregate standpoint, productive private investment. In a flexible accelerator model, that relates investment to recent increases in demand and production (after correcting for deviations of capacity utilization), we have introduced distributive variables (real interest rates and profits shares), a proxy of geo-political uncertainty (oil prices) and financial variables (exchange rates and stock exchange indexes). The last group is supposed to account for financial uncertainty. The majority of our selected variables appear as deviations from their conventional values. This is our strategy to deal with uncertainty, that affects to both, real and financial variables.

We have tested our macro accumulation function with panel data from 12 OECD countries for the period 1970-2010 using annual data. The GMM method is able to find the common structure of accumulation and isolate the specific key variables in different countries. From the econometric point of view it is able to correct problems of autocorrelation, heterocedasticity and cross-sectional dependence.

The analysis permits us to conclude that the key determinant of the accumulation rate is the expected rate of growth of demand, approximated the lagged rate of growth of GDP. We find a positive influence of deviations (from their conventional levels) of the utilization of capacity and the profit shares. Deviations of the real exchange rate and volatility of oil prices affect accumulation in a negative way. The development of stock exchange markets and increases in the cost of financial resources depress accumulation.

The empirical results suggest that the strategy of policymakers should be aimed at:

(1) Stabilizing the aggregate level of demand, since demand expectations are the key determinant of accumulation.

(2) Regulating financial institutions and financial markets in order to reduce uncertainty.

(3) Reinforcing the role of central Banks as lenders of last resort to avoid liquidity problems and bank crunches that impair private investment.

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APPENDIX I

Basic definitions of the variables:

a: rate of accumulation of capital.

$$a_{i,t} = \frac{K_{i,t} - K_{i,t-1}}{K_{i,t-1}} = \frac{I_{i,t}}{K_{i,t-1}} \quad (15)$$

K: stock of productive capital.

I: productive investment.

g: rate of growth of GDP.

$$g_{i,t-1} = \frac{GDP_{i,t-1} - GDP_{i,t-2}}{GDP_{i,t-2}} \quad (16)$$

du: deviations between the effective capacity utilization (*u*) and its "normal" level (*u**).

$$du_{i,t-1} = \frac{u_{i,t-1} - u^*}{u^*} \quad (17)$$

π: profit share.

i: real long-term interest rate.

de: deviations of the real exchange rate (*e*) from its "conventional" level (*e**).

$$de_{i,t-1} = \frac{e_{i,t-1} - e^*}{e^*} \quad (18)$$

do: deviations of the current volatility of oil prices (*o*) from its "conventional" level (*o**).

$$dv_{i,t-1} = \frac{v_{i,t-1} - v^*}{v^*} \tag{19}$$

X: stock-exchange market. It is compute by using the logarithm of the variable.

α_0: independent term.

α_i: estimated coefficients.

ε_{ij}: error term.

APPENDIX II

The Hodrick and Prescott (Hodrick and Prescott, 1980) filter permits to isolate the trend component, g_t, and the cyclical component, c_t, which compose a time series, x_t, in the following way:

$$x_t = g_t + c_t \tag{20}$$

To capture the cyclical component the HP filter solves the next minimization problem:

$$\min \sum_{t=1}^{T} \left[(x_t - g_t)^2 + \lambda \left((g_{t+1} - g_t) - (g_t - g_{t-1}) \right)^2 \right] \tag{21}$$

The former element measures the fitness of the time series while the latter one is a measure of the smoothness. This minimization problem introduces a *trade-off* parameter, λ, which solves the conflict between *goodness of fit* and *smoothness*.